METHOD AND APPARATUS FOR ORIENTING AN OPTICAL POLYMER FILM, AND TENTER APPARATUS FOR THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method and an apparatus for orienting an optical polymer film, and further relates to a tenter apparatus improved so as to prevent film-gripping looseness from occurring due to orientation of a film.

2. Description of the Related Art

In recent years, demand for polarizing plates increases rapidly as liquid-crystal display devices are popularized. In a general method for producing the polarizing plate, an optical polymer film of PVA (polyvinyl alcohol) and so forth is cleaned first with a cleaning fluid while the polymer film passes through a cleaning bath. This polymer film is a base material of a polarizer. Successively, a dyeing process is performed with a dyeing fluid while the optical polymer film passes through a dyeing bath. Then, a hardening process is performed in an aqueous solution of hardener of boric acid and so forth while the optical polymer film passes through a hardening bath. During the hardening process, the optical polymer film is oriented. After orientation, the optical polymer film is dried. In this way, a polarizing film is produced. Both surfaces of the

produced polarizing film are laminated with a TAC film. Meanwhile, such as described in Japanese Patent Laid-Open Publication No. 2002-86554, there is another method for obtaining the polarizing film by orienting a film in the air after the respective processes of dyeing, hardening and so forth. With respect to the optical polymer film, it is possible to use an appropriate polymer film which is soluble in a volatile solvent. Polycarbonate, cellulose acylate, polysulfone and so forth may be used besides the PVA.

According to this sort of the orienting method, unevenness sometimes occurs on the polarizing plate being as a product. It is desired to improve this unevenness.

In the meantime, a tenter apparatus for producing the polarizing plate has clips for gripping side edges of the film. The clips run along right-and-left guide rails at the same speed to move the film. During the movement, the film is preheated, and after that, the film is oriented in a width direction. It is demanded in view of weight saving that the film for the polarizing plate is a thin film. For this demand, it is required to laterally orient the film having small stiffness.

In general, the film for the polarizing plate is oriented after fluid-processing of dyeing, hardening and so forth. When the film has small stiffness, a surround of a portion caught by the clip becomes thin upon orienting the film. Due to this, film-gripping force by the clip

lowers so that the film sometimes slips out of the clip during or after orientation. Particularly, in a tenter apparatus for obliquely orienting the film such as described in the above-noted Publication No. 2002-86554, the right-and-left guide rails are curved and the film is drawn in an oblique direction at a curved portion so that the film slips in the clip and sometimes comes out of the clip. Moreover, also in a case of multi-step orientation, the film sometimes slips out of the clip at turn potions of the orientation.

SUMMARY OF THE INVENTION

In view of the foregoing, it is a primary object of the present invention to provide a method and an apparatus for orienting an optical polymer film in which orientation unevenness is prevented from occurring.

It is a second object of the present invention to provide a tenter apparatus in which film-gripping looseness of a clamper is prevented from being caused by orientation.

In order to achieve the above and other objects, the inventors of this application have made an analysis. As a result, the following facts are cleared. The orientation unevenness is caused by distribution unevenness of moisture, which is absorbed in a PVA film at a processing step of each fluid before orientation. The distribution unevenness of the moisture occurs due

to a source that the processing fluid remains on a surface of the PVA film at an exit of each processing bath. When there are plural processing baths, the distribution unevenness of the first processing bath most largely affects the orientation unevenness. In view of this, the orienting method according to the present invention comprises a step of removing the fluid existing on the optical polymer film. The fluid is removed by using a draining member within 10 seconds after the optical polymer film has left the processing bath. In this orienting method, the polymer film is oriented after passing through the processing bath containing the fluid.

Further, as another result of inventor's analysis, in a method for obtaining a polarizing film by orienting a film in the air such as described in the above-noted Publication No. 2002-86554, it also turns out that the orientation unevenness is largely affected by the distribution unevenness of the moisture remaining at the exit of the processing bath to be used just before the orientation. In view of this, the polymer-film orienting apparatus of the present invention comprises the draining member disposed near the film exit of the processing bath to be used just before the orientation. The draining member removes the fluid existing on the optical polymer film. In this polymer-film orienting apparatus, the polymer film is oriented by a tenter in a pneumatic atmosphere after passing through the processing bath

containing the fluid. Incidentally, the draining member is preferable to be a draining roller or a draining blade.

In the tenter apparatus of the present invention, a sheet-like material to be oriented is conveyed along a first rail and a second rail such that both side edges thereof are held by openable gripping tools. The tenter apparatus has a gripping-force aid member for applying a force to the clamper in a closed direction thereof. The gripping-force aid member is disposed within a range running from a grip commencement position of the clamper to a gripping terminal position thereof. When the first and second rails are constituted of plural orienting areas for performing orientation plural times, it is preferable to dispose the gripping-force aid member within at least one of the plural orienting areas. Further, when the first and second rails are constituted of a linear portion and an arc-like curving portion, it is preferable to dispose the gripping-force aid members in front and in rear of the curving portion. Incidentally, the sheet-like material is preferable to be a film processed in fluid. Moreover, it is preferable to dispose the gripping-force aid member at a front position of a thermal process.

According to the present invention, the existing fluid is removed by using the draining member within 10 seconds after the PVA film has left the processing bath. Thus, it is possible to prevent the unevenness from

occurring on the PVA film after the orientation. Moreover, since the existing fluid of the PVA film is removed, the film is stably gripped at an orienting section.

According to the present invention, the tenter apparatus has the gripping-force aid member for applying the force to the clamper in the closed direction. In virtue of this, the gripping force of the sheet-like material applied by the clamper increases so that the sheet-like material is prevented from slipping out of the clamper during and after orientation.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and advantages of the present invention will become apparent from the following detailed description of the preferred embodiments of the invention when read in conjunction with the accompanying drawings, in which:

Fig. 1 is a plan view schematically showing an apparatus for orienting an optical polymer film (PVA film) according to the present invention;

Fig. 2 is a side view schematically showing a film-surface processing apparatus;

Figs. 3A and 3B are perspective views showing a draining roller pair and a draining blade pair;

Fig. 4 is a side view showing a state set just before gripping clips;

Fig. 5 is a side view showing a state set just after gripping the clips;

Fig. 6 is a perspective view showing an opening operation of the clip, and showing a recovery state of a gripping force caused by a close cam;

Fig. 7 is a side view showing the recovery state of the gripping force caused by the close cam; and

Fig. 8 is a plan view schematically showing an apparatus for orienting the optical polymer film (PVA film) according to another embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

According to the present invention, it is possible to obtain an oriented film having a good surface upon orienting a damp film after a fluid-bath process. The following description relates to oblique orientation, which seems to derive a good yield for producing a polarizing plate. In particular, the following description relates to 45° orientation. Incidentally, uniaxial orientation being general as a tenter is effectively adopted. Moreover, biaxial orientation and multi-step orientation are effectively adopted as well. Fig. 1 is a plan view schematically showing a polymer-film orienting machine 2 according to the present invention. This orienting machine 2 is constituted of

a processing apparatus 3 and a tenter apparatus 4. Hereinafter, an orienting apparatus for a PVA (polyvinyl alcohol) film 6 is featured. The PVA film is a representative of optical polymer films and is a base material of a polarizer. Such as shown in Fig. 2, the processing apparatus 3 includes a cleaning bath 7, a dyeing bath 8 and a hardening bath 9 in order from an upstream side in a conveyance direction of the PVA film 6, namely from the left side in the drawing. The cleaning bath 7 has functions removing wastes adhering to the PVA film 6 and facilitating penetration of processing fluid in the next processing bath. Exits of the respective baths are provided with first to third draining roller pairs 11 to 13. First to third draining blade pairs 21 to 23 are disposed at downstream sides (upper sides) of the first to third draining roller pairs 11 to 13 respectively. Each of the baths 7 to 9 is provided with plural conveyor rollers 15 to convey the PVA film 6 in the respective baths 7 to 9. Incidentally, the first to third draining roller pairs 11 to 13 and the first to third draining blade pairs 21 to 23 may be air-knife pairs. By the way, in this specification, meaning of orienting and orientation includes stretching and so forth.

The cleaning bath 7 contains cleaning fluid by a predetermined amount. The dyeing bath 8 contains aqueous fluid of dyeing agent of iodine and so forth by a predetermined amount. The hardening bath 9 contains

aqueous fluid of hardener of boric acid and so forth by a predetermined amount. A cleaning process, a dyeing process and a hardening process are carried out for the PVA film 6 inserted from an entrance 17 and conveyed through the respective baths 7 to 9 by means of the conveyor rollers 15. The processing fluid existing on a surface of the PVA film is removed every bath by the first to third draining roller pairs 11 to 13 and the first to third draining blade pairs 21 to 23. After removing the processing fluid, the PVA film is sent to the next bath. Such as shown in Fig. 1, the PVA film 6 processed by the processing apparatus 3 is conveyed to the tenter apparatus 4 in a damp state. The tenter apparatus 4 orients the PVA film 6 in an atmosphere of high temperature and high humidity. The oriented PVA film 6 is discharged from an exit 18.

Such as shown in Fig. 3A, the first draining roller pair 11 is constituted of two draining rollers 11a so as to interpose the PVA film 6. The first draining roller pair 11 is rotated by a motor, which is not shown. Similarly, the second draining roller pair 12 is constituted of two draining rollers 12a and the third draining roller pair 13 is constituted of two draining rollers 13a. The second and third draining roller pairs are respectively rotated by a motor, which is not shown. The first to third draining roller pairs 11 to 13 nip and convey the PVA film 6 transported from the respective

baths 7 to 9. In virtue of the nipping conveyance, fluid existing on the surface of the PVA film 6 is removed. The removed fluid is returned to the respective baths 7 to 9. Incidentally, it is not necessary to drive the first to third draining roller pairs 11 to 13. In this case, the first to third draining roller pairs 11 to 13 are rotated by a driving force, which is received from the PVA film 6, at the same speed with the PVA film 6.

Arrangement positions of the first to third draining roller pairs 11 to 13 may be changed. The first to third draining roller pairs 11 to 13 are disposed at positions to which the PVA film 6 reaches within 10 seconds after passing through the respective baths 7 to 9, preferably within 5 seconds, more preferably within 3 seconds, and most preferably just after passing the respective baths 7 to 9 (within 0.5 seconds). Thus, distance D between fluid surfaces of the respective baths 7 to 9 and the first to third draining roller pairs 11 to 13 is determined in accordance with a conveyance speed V of the PVA film 6. For example, when the conveyance speed V of the PVA film 6 is 100mm/s, the first to third draining roller pairs 11 to 13 are disposed within 1000mm from the fluid surfaces of the respective baths 7 to 9. In this case, the first to third draining roller pairs 11 to 13 are preferable to be disposed within 100mm, and are much preferable to be disposed within 60mm. By changing the arrangement positions of the first to third draining

roller pairs 11 to 13, it is possible to deal with changes regarding the conveyance speed of the PVA film 6 and fluid-surface heights of the respective baths 7 to 9.

The draining rollers 11a to 13a are made of rubber, and have hardness of 40 to 90 degrees, surface roughness of 0.5 to 50 S, and linear pressure of 100 to 1000 N/m. It is preferable that the hardness is 50 to 90 degrees, the surface roughness is 0.5 to 10 S, and the linear pressure is 100 to 500 N/m. Owing to this, it is prevented to remove the fluid penetrating into the PVA film 6 even if draining is performed to excess. Further, the film surface is not damaged. Incidentally, besides the rubber, it is possible to use other materials on condition that the hardness and the surface roughness are identical with that of the rubber.

Such as shown in Figs. 2 and 3, the first draining blade pair 21 is constituted of two draining blades 21a having a wedge shape. The two draining blades 21a are disposed at positions shifted in a conveying direction A of the PVA film 6 so as to interpose the PVA film 6. Similarly, the second draining blade pair 22 is constituted of two draining blades 22a, and the third draining blade pair 23 is constituted of two draining blades 23a. The couple of the draining blades are disposed so as to be shifted in the conveying direction A of the PVA film 6. By interposing the PVA film 6, the fluid existing on the surface thereof is removed and is

returned to the respective baths 7 to 9.

The draining blades 21a to 23a are made of metal, plastic, glass or ceramic. A toe thereof for coming into contact with the PVA film 6 has a radius R of 1mm and surface roughness of 5S. Incidentally, the radius R of the toe is preferable to be 0.1 to 1 mm, and the surface roughness thereof is preferable to be 5S or less. Owing to this, it is prevented to remove the fluid penetrating into the PVA film 6 even if removal is performed to excess. Further, the film surface is not damaged.

Such as shown in Fig. 1, the tenter apparatus 4 is constituted of a right rail 31, a left rail 32 and endless chains 33 and 34 guided by the rails 31 and 32. A large number of clips 24 being as clampers are attached to the endless chain 33 and 34 at predetermined intervals. The clip 24 grips a side edge of the PVA film 6 and is moved by a driving mechanism along either of the rails 31 and 32 so that the PVA film 6 is oriented.

The tenter apparatus 4 includes a preheating section 4a, an orienting section 4b, and a thermal-processing section 4c. The preheating section 4a and the orienting section 4b are kept at high temperature and high humidity in order to easily orient the PVA film 6. In the tenter apparatus 4, each of the right and left rails 31 and 32 draws a curving locus individually so that the PVA film 6 is oriented in a direction which is not perpendicular to a longitudinal direction thereof. Thus, the PVA film

6 becomes an optical polymer film having an oblique orientation axis.

Successively, an operation of this embodiment is described below. The PVA film 6 inserted from the entrance 17 is conveyed to the cleaning bath 7 of the processing apparatus 3. The cleaning bath 7 contains the cleaning fluid by a predetermined amount. The PVA film 6 is cleaned while conveyed in the cleaning bath 7 by means of the conveyor roller 15. The cleaned PVA film 6 is conveyed to the first draining roller pair 11 in a state that the fluid exists on the surface thereof. At this time, the conveyance speed V of the PVA film 6 is 100 mm/s, and the first draining roller pair 11 is disposed at a position separated from the fluid-surface of the cleaning bath 7 by 60 mm. Thus, the cleaned PVA film 6 reaches the first draining roller pair 11 when a period of 0.6 seconds has elapsed after passing though the fluid-surface of the cleaning bath 7.

The first draining roller pair 11 nips and conveys the PVA film 6 with the two draining rollers 11a. By nipping and conveying the PVA film 6, the fluid existing on the surface thereof is removed and returned to the cleaning bath 7. After the first draining roller pair 11 has removed the fluid of the surface, the PVA film 6 is conveyed to the first draining blade pair 21. The fluid, which is not perfectly removed by the first draining roller pair 11 and exists on the surface of the PVA film

6, is removed by the two draining blades 21a and is returned to the cleaning bath 7.

The PVA film 6 cleaned by the cleaning bath 7 is conveyed to the dyeing bath 8 to carry out the dyeing process. Similarly to the cleaning bath 7, above the dyeing bath 8, the fluid existing on the surface of the dyed PVA film 6 is removed by the second draining roller pair 12 and the second draining blade pair 22. The removed fluid is returned to the dyeing bath 8. Similarly to the first draining roller pair 11, the second draining roller pair 12 is disposed at a position separated from the fluid-surface of the dyeing bath 8 by 60 mm.

The PVA film 6 dyed by the dyeing bath 8 is conveyed to the hardening bath 9 to carry out the hardening process. Similarly to the cleaning bath 7, above the hardening bath 9, the fluid existing on the surface of the hardened PVA film 6 is removed by the third draining roller pair 13 and the third draining blade pair 23. The removed fluid is returned to the hardening bath 9. Similarly to the first draining roller pair 11, the third draining roller pair 13 is disposed at a position separated from the fluid-surface of the hardening bath 9 by 60 mm.

The PVA film 6 for which the processing apparatus 3 has carried out the cleaning, dyeing and hardening processes is conveyed to the tenter apparatus 4. The side edges of the PVA film 6 are gripped by the clips 24, and in this state, the clips 24 are moved along the respective

rails 31 and 32 by means of a driving mechanism to orient the PVA film 6. The preheating section 4a and the orienting section 4b are kept at the high temperature and the high humidity in order to easily orient the PVA film 6. The oriented PVA film 6 is released from the grip of the clip 24 at a nearby portion of the exit 18. The released PVA film 6 is discharged from the exit 18.

As to the PVA film 6 discharged from the exit 18, the orientation axis slants by 45° in virtue of 45-degree orientation. The discharged PVA film 6 is the optimum film as a polarizing film. By laminating a TAC film on this polarizing film, the polarizing plate is produced.

In the above embodiment, the conveyance speed of the film is 100 mm/s, and the distance between the respective draining roller pairs and the fluid-surfaces of the respective baths is 60 mm. Further, the film reaches the respective draining roller pairs when the period of 0.6 seconds has elapsed after passing through the respective baths. However, these are not exclusive. The distance may be properly changed in accordance with the conveyance speed under a condition that it is possible to reach within 10 seconds. It is most preferable to dispose the draining roller pairs at positions where the film reaches thereto just after passing through the respective baths (after 0.5 sec., for instance).

In the above embodiment, the draining roller pair and the draining blade pair are used as draining members.

However, any one of them may be used. Alternatively, an air knife may be used. Although the draining rollers and the draining blades are provided as the pair so as to be opposite to each other, these may be disposed in a zigzag state. Meanwhile, one of the surfaces may be adapted to come into contact with the draining roller, and the other of the surfaces may be adapted to come into contact with the draining blade.

In the above embodiment, the processing apparatus 3 is constituted of three baths, which are the cleaning bath 7, the dyeing bath 8 and the hardening bath 9. However, new baths of a coloring bath and so forth may be added as the need arises. Meanwhile, it is possible to reduce the number of the baths by integrating the dyeing bath and the hardening bath into a single bath, for example.

Next, a second embodiment of the present invention is described below. According to this embodiment, it is possible to stably feed a damp film, for which a fluid-bath process has been carried out, to an orienting tenter. The following description relates to oblique orientation, which seems to derive a good yield for producing a polarizing plate. In particular, the following description relates to 45° orientation. Incidentally, uniaxial orientation being general as a tenter is effectively adopted. Moreover, biaxial orientation and multi-step orientation are effectively adopted as well. A polymer-film orienting machine 2, or a PVA-film

orienting machine 2 according to this embodiment is shown in Fig. 1. The PVA-film orienting machine 2 is constituted of a processing apparatus 3 and a tenter apparatus 4. The processing apparatus 3 includes a cleaning bath 7, a dyeing bath 8 and a hardening bath 9 in order from an upstream side in a conveyance direction of the PVA film 6, namely from the left side in the drawing. The cleaning bath 7 contains cleaning fluid by a predetermined amount. The dyeing bath 8 contains aqueous fluid of dyeing agent of iodine and so forth by a predetermined amount. The hardening bath 9 contains aqueous fluid of hardener of boric acid and so forth by a predetermined amount. A cleaning process, a dyeing process and a hardening process are carried out for the PVA film 6 inserted from an entrance 17 and conveyed through the respective baths 7 to 9 by means of a conveying mechanism. The PVA film 6 processed by the respective baths 7 to 9 is conveyed to the tenter apparatus 4 in a damp state. Incidentally, the processing apparatus 3 is constituted of three baths, which are the cleaning bath 7, the dyeing bath 8 and the hardening bath 9. However, new baths of a coloring bath and so forth may be added as the need arises. Meanwhile, it is possible to reduce the number of the baths by integrating the dyeing bath and the hardening bath into a single bath, for example.

Such as shown in Fig. 1, the tenter apparatus 4 is constituted of a right rail 31, a left rail 32 and endless

chains 33 and 34 guided by the rails 31 and 32. A large number of clips 24 being as clampers are attached to the endless chains 33 and 34 at predetermined intervals. The clip 24 grips a side edge of the PVA film 6 and is moved along either of the rails 31 and 32 so that the PVA film 6 is oriented.

The endless chain 33 is laid between a driving sprocket 37 and a driven sprocket 39. The endless chain 34 is laid between a driving sprocket 38 and a driven sprocket 40. The endless chain 33 is guided by the right rail 31 between the sprockets 37 and 39. The endless chain 34 is guided by the left rail 32 between the sprockets 38 and 40. The driving sprockets 37 and 38 are disposed at a tenter gateway 20 and are rotated by a drive mechanism, which is not shown. The driven sprockets 39 and 40 are disposed at an exit 18 of the tenter.

The tenter apparatus 4 includes a preheating section 4a, an orienting section 4b, and a thermal-processing section 4c. The preheating section 4a and the orienting section 4b are kept at high temperature and high humidity in order to easily orient the PVA film 6.

As shown in Fig. 4, the clip 24 is constituted of a frame 25 having a U-like shape, a flapper 26 and a rail attachment 27. The flapper 26 is rotatably attached to the frame 25 via an attachment shaft 25a. The right and left endless chains 33 and 34 are attached to the rail attachments 27. Fig. 4 shows a state set just before

commencement of gripping, and Fig. 5 shows a state set just after gripping. The flapper 26 moves between a film-gripping position (closed position) where the flapper 26 is kept in a perpendicular condition, and an open position where a head 26a thereof abuts on an opening member 28 to keep an obliquely-rotated condition. The flapper 26 is usually urged by self-weight so as to be kept in the film-gripping position. At a film-gripping position PA, the PVA film 6 is gripped by a film-gripping surface 25b and a flapper bottom surface 26b. A conveyor roller 29 is rotated by a motor, which is not shown, to convey the PVA film 6 in a film advancing direction A1 toward the film-gripping position PA.

The rail attachment 27 is constituted of an attachment frame 30 and guide rollers 51, 52 and 53. The attachment frame 30 is fixed to either of the right endless chain 33 and the left endless chain 34. The guide rollers rotate, coming into contact with support surfaces of the driving sprockets 37 and 38 such as shown in Fig. 4. Alternatively, the guide rollers rotate, coming into contact with support surfaces of the right and left rails 31 and 32 such as shown in Fig. 5. Thus, the clips 24 are guided along the respective rails 31 and 32 without slipping out of the respective sprockets 17, 18 and the respective rails 31, 32.

As shown in Figs. 4 and 6, the opening members 28 of the clips 24 are disposed near the sprockets 37 to

40. At the side of the driving sprockets 37 and 38 of the tenter gateway 20, the opening member 28 abuts on the head 26a of the clip 24 and sets the open state thereof prior to the film-gripping position PA in order to receive the side edge of the PVA film 6. When the clip 24 passes the film-gripping position PA, the opening member 28 is separated from the head 26a and the clip 24 is set from the open position to the gripping position to grip the side edge of the PVA film 6. Similarly, at the side of the driven sprockets 39 and 40 of the tenter exit 18, the clip 24 is kept in the open position by means of the opening member 28 when passing a film-gripping release position PB. Thus, gripping the side edge of the PVA film 6 is released.

At rail-curving positions PC and PD of the rails 31 and 32 (see Fig. 1), clip closers 35 are disposed such as shown in Figs. 6 and 7 in order to recover the film-gripping force of the clip 24. The clip closer 35 is constituted of a frame 36, a close cam 41, a linear bush housing unit 42, a spring 43, a shaft 44 and a stopper 45.

The shaft 44 is attached to the frame 36 so as to be movable in a right-and-left direction. The shaft 44 is urged toward the outside by means of the spring 43. Since the spring 43 is attached to the stopper 45, a load of the spring 43 may be changed by shifting a position of the stopper 45. It is possible to change a fixing

position of the linear bush housing unit 42 relative to the shaft 44. The close cam 41 is attached to the shaft 44. A curving portion 41a of the close cam 41 has a curving shape corresponding to that of the rail-curving positions PC and PD of the rails 31 and 32. Incidentally, the linear bush housing unit 42 is not restricted if it is possible to fix the shaft 44 and to change the fixing position thereof.

The close cam 41 abuts on the head 26a of the clip 24 at each of the rail-curving positions PC and PD to apply a force in a closing direction thereof. In a case that the clip 24 moves along the rail 31, the flapper 26 is rotated in a clockwise direction. In a case that the clip 24 moves along the rail 32, the flapper 26 is rotated in a counterclockwise direction. Owing to this, the film-gripping force of each clip 24 increases.

The close cam 41 is formed with a taper portion 41b positioned at an upstream side in the film-advancing direction A1. The taper portion 41b guides the head 26a. In accordance with the film-gripping force of the clip 24, the shaft 44 is moved by the linear bush housing unit 42 to determine the fixing position. The close cam 41 made of plastic is preferably used in order to hold down contact resistance relative to the head 26a. As to the plastic, is used nylon, Delrin and so forth.

An operation of this embodiment is described below. The PVA film 6 inserted from the entrance 17 is conveyed

to the cleaning bath 7 of the processing apparatus 3. The PVA film 6 is cleaned, dyed and hardened while conveyed by the conveyor mechanism through the cleaning bath 7, the dyeing bath 8 and the hardening bath 9. The PVA film 6, the surface of which has been processed by the respective baths 7 to 9, is conveyed to the tenter apparatus 4.

The PVA film 6 conveyed to the tenter apparatus 4 is advanced to the film-gripping position PA by the conveyor roller 29. Incidentally, a tension roller pair for applying tension to the PVA film 6 in a width direction may be provided at the tenter gateway 20. Moreover, an upper guide roller for preventing upward transformation of the PVA film 6 may be provided in just front of the film-gripping position PA. Further, right-and-left film guides for guiding both the side edges of the PVA film 6 may be provided within a range running from the tenter gateway 20 to the film-gripping position PA.

At the tenter gateway 20, the clip 24 is kept in the open state by the opening member 28. When the PVA film 6 enters the clip 24 at the film-gripping position PA, the clip 24 is closed to grip the PVA film 6. The clips 24 grip the side edges of the PVA film 6 and are moved along the rails 31 and 32 to orient the PVA film 6. The preheating section 4a and the orienting section 4b are kept at high-temperature and high-humidity in order to easily orient the PVA film 6.

The clip closers 35 are disposed at the rail-curving

positions PC and PD of the rails 31 and 32. The close cam 41 positioned by the linear bush housing unit 42 abuts on the head 26a of the clip 24 to apply the force in the closing direction so that the reduced film-gripping force of the clip 24 is recovered by the clip closer 35. In virtue of this, the PVA film 6 is prevented from slipping out of the clip 24. The clip closer 35 can change the load of the spring 43 by shifting the position of the stopper 45. Thus, it is possible to regulate the film-gripping force of the clip 24 by adjusting the force to be applied to the clip 24.

Gripping of the clip 24 is released by the opening member 28 at the film-gripping release position PB. And then, the oriented PVA film 6 is discharged from the tenter exit 18.

As to the PVA film 6 discharged from the tenter exit 18, the orientation axis is inclined by the oblique orientation so that the PVA film 6 becomes the optimum polarizing film. By laminating the TAC film on the polarizing film, the polarizing plate is produced. Regarding the oblique orientation, 45°-orientation is preferable.

In the above embodiment, the clip closers 35, a number of which is two, are disposed at the rail-curving positions PC and PD. However, this is not exclusive. Arrangement positions of the clip closers 35 and the number thereof may be modified within a range running from the film

gripping position PA to the film-gripping release position PB. It is preferable to arrange the clip closers 35 after the orientation. Alternatively, it is preferable to arrange the clip closers 35 in front and in rear of a position where the force for orienting the PVA film 6 greatly changes, namely, in front and in rear of the orienting stage. Further, it is effective to arrange the clip closers 35 in front and in rear of a position where tension caused from the film inward changes. For instance, it is preferable to arrange the clip closers 35 at a region where a film-shrinking force caused by the thermal process is likely to occur. In particular, it is preferable to arrange the clip closer 35 in front of the thermal-processing section 4c, and it is further preferable to arrange the clip closer 35 at a region where a thermal-processing temperature greatly changes. Incidentally, great change of the thermal-processing temperature means 5° C or more.

In the above embodiment, is used the clip of the style rotating by utilizing the self-weight. Besides this kind of the clip, it is possible to use the other clips, which are operated by a spring and have various drive members.

Fig. 8 shows a third embodiment. Components similar to the above embodiments are denoted by the same reference numeral, and detailed description thereof is abbreviated. In this embodiment, the tenter apparatus 4 orients the PVA film 6 in two steps as multi-step orientation. Thus,

a right rail 47 and a left rail 48 are provided with first orienting areas 47a, 48a and second orienting areas 47b, 48b so as to orient the PVA film 6 in two steps. Upon orientation, the PVA film 6 is drawn to be thin so that the film-gripping force of the clip 24 lowers. In consideration of this, the clip closers 35 are disposed at orientation terminal positions PE and PF of the first and second orienting areas 43a, 44a, 43b and 44b. The close cam 41 abuts on the head 26a of the clip 24 at the orientation terminal positions PE and PF to apply the force in the closing direction thereof. In this way, the film-gripping force of the clip 24 increases so that the PVA film is prevented from slipping out of the clip 24.

In the third embodiment, the two-step orientation shown in Fig. 8 is described as an example of the multi-step orientation. However, the multi-step orientation may be two steps or more. In a case of three-step orientation or more, it is also preferable to dispose the clip closers 35 at orientation terminal positions of the respective steps.

In the meantime, the following description is relative to the forgoing respective embodiments.

If there is a difference between right and left advancing speeds of the PVA film 6 at the exit 18 of the tenter apparatus 4, creases and twists occur at the exit 18. In view of this, it is required that the speeds of the right and left clips 24 are substantially same. The

speed difference is preferable to be 1% or less, and is much preferable to be less than 0.5%, and is most preferable to be less than 0.05%. In this description, the speed means a locus length of each of the right and left clips 24 advancing for a minute. In a general tenter apparatus or the like, speed unevenness having an order of one second or less occurs in accordance with a cycle of a sprocket tooth for driving a chain, a frequency of a driving motor thereof, and so forth. Sometimes, the unevenness of a few percent occurs. However, such unevenness is not regarded as the speed difference mentioned in the present invention.

By performing the orientation with the polymer-film orienting machine 2 according to the present invention, it becomes possible to utilize the PVA film 6 as the polarizing film having excellent polarizing ability. With respect to the obtained PVA film 6 being as the polarizing film, at least one surface thereof is laminated with a protect film via an adhesive layer to obtain the polarizing plate. This obtained polarizing plate is excellent in single-plate transmittance and degree of polarization. Thus, image contrast may be improved when the obtained polarizing plate is used as a liquid-crystal display device.

Incidentally, degree of saponification of polyvinyl alcohol is not especially limited. However, in consideration of solubility and so forth, the degree of

saponification is preferable to be 80 to 100 mol%, and is particularly preferable to be 90 to 100 mol%. Further, degree of polymerization of polyvinyl alcohol is not especially limited. The degree of polymerization, however, is preferable to be 1000 to 10000, and is particularly preferable to be 1500 to 5000.

Before the orientation, preferable elastic modulus of the PVA film 6 is 0.01 MPa or more and is 5000 MPa or less, which are represented in Young's modulus. More preferably, the elastic modulus is 0.1 MPa or more and is 500 MPa or less. When the elastic modulus is too low, a degree of shrinkage during and after the orientation becomes low so that it becomes difficult to clear the creases. In contrast, when the elastic modulus is too high, tension to be applied during the orientation becomes large. Thus, it is necessary to increase a strength of a portion holding both the lateral sides of the PVA film 6 so that a load relative to the tenter apparatus 4 increases.

Although a thickness of the PVA film 6 is not especially limited in advance of the orientation, the thickness of 1μm to 1mm is preferable in view of film-holding stability and orienting homogeneity. The thickness of 20 to 200 μm is particularly preferable.

The dyeing agent used in the present invention is organic dichroic dye and/or multi-iodide ion of I3-, I5- and so forth produced with iodine-potassium iodide. As

examples of the dichroic dye, there are dye-based compounds of azo dye, stilbene dye, pyrazolone dye, triphenylmethane dye, quinoline dye, oxazine dye, thiazine dye and anthraquinone dye. Although it is preferable to be water-soluble, this is not exclusive. Further, it is preferable to introduce hydrophilic substituting groups of sulfonic acid group, amino group, hydroxyl group and so forth, into dichroic molecule of the dichroic dyes. As examples of the dichroic molecule, there are C. I. Direct Yellow 12, C. I. Direct Orange 39, C. I. Direct 72, C. I. Direct Red 39, C. I. Direct Red 79, C. I. Direct Red 81, C. I. Direct Red 83, C. I. Direct Red 89, C. I. Direct Violet 48, C. I. Direct Blue 67, C. I. Direct Blue 90, C. I. Direct Green 59, C. I. Acid Red 37, and so forth. Further, there are dyes and so forth described in Japanese Patent Laid-Open Publication Nos. 62-70802, 1-161202, 1-172906, 1-172907, 1-183602, 1-248105, 1-265205 and 7-261024. These dichroic molecules are used as free acid or salt of alkali metal salt, ammonium salt and amine group. By compounding two or more kinds of the dichroic molecules, it is possible to produce a polarizer having various hues. Compounds (dyes), which take on black as a polarizing plate when an absorption axis is perpendicular, are preferable because both of the single-plate transmittance and the degree of polarization are excellent. Moreover, it is preferable to compound the various dichroic molecules

so as to take on black, because excellent single-plate transmittance and excellent degree of polarization are obtained. With respect to the film oriented by the film orienting machine 2 of the present invention, is preferably used the multi-iodide ion of I3-, I5- and so forth produced with iodine-potassium iodide.

When the multi-iodide ion of I3-, I5- and so forth produced with iodine-potassium iodide is used as the polarizer, the iodine is preferable to be 0.1 to 20 g/l. Further, the potassium iodide is preferable to be 1 to 200 g/l, and a mass ratio of the iodine to the potassium iodide is preferable to be 1 to 200. A period for dyeing is preferable to be 10 to 5000 seconds. Temperature of the fluid is preferable to be 5 to 60 °C.

As to the hardener (crosslinking agent), it is possible to use the one described in U.S. reissue patent No. 232897. In practical use, boric acid and borax are preferably used. It is also possible to use metal salt of zinc, cobalt, zirconium, iron, nickel, manganese and so forth.

A rate for orienting the PVA film 6 is 1.1 times/minute or more, and is preferable to be 2 times/minute or more, wherein the rate is represented as a magnification of orientation in unit time. Faster rate is preferable. Meanwhile, the advancing speed in the longitudinal direction is 0.1 m/minute or more, and is preferable to be 1 m/minute or more. Faster advancing speed is

preferable in view of productivity. In the respective cases, the upper limit differs in accordance with the tenter apparatus 4 and the PVA film 6 to be oriented.

In the polymer-film orienting machine 2 of the present invention, when the clips 24 grip both the side edges of the PVA film 6, it is preferable that the PVA film 6 is kept in a strain state so as to be easily griped. In a concrete method, the film is strained by applying tension in the longitudinal direction of the PVA film 6.

Environmental temperature at the time of orientation is preferable to be 25°C or more and to be 90°C or less. A rage of much preferable temperature is between 40°C and 90°C.

With respect to moisture at the time of orientation, it is preferable to perform the orientation under a moisture-conditioning atmosphere. Preferably, the moisture is 50% or more and is 100% or less. More preferably, the moisture is 80% or more and is 100% or less.

As to the polarizing film obtained by the polymer-film orienting machine 2 of the present invention, at least one surface thereof may be directly laminated with various films functioning as a protect film. As examples of the functional films, there are phase-contrast films of $\lambda/4$ plate, $\lambda/2$ plate and so forth, a light-diffusing film, a plastic cell provided

with a conductive layer on an opposite surface to the polarizing plate, a brightness enhancement film having an anisotropic scattering function, an anisotropic optical interference function and so forth, a reflecting plate, and a reflecting plate having a semi-transmission function.

It is possible that the preferable protect films, which are mentioned above, are used so as to overlap one or more thereof. Although both the surfaces of the polarizing film may be laminated with the same protect films, the surfaces of the polarizing film may be respectively laminated with the protect films having different functions and physical properties. Moreover, only one of the surfaces may be laminated with the protect film, and the opposite surface may be directly provided with an adhesive layer without the protect film in order to directly laminate a liquid-crystal cell. In this case, it is preferable to provide a separator film, which is capable of peeling off, at the outside of the adhesive layer.

As to the PVA film 6 to be oriented by the polymer-film orienting machine 2 of the present invention, many of them have a thin thickness. In order to avoid troubles of rips or the like of the PVA film 6 to be caused at the time of handling, it is preferable to comprise a step in which at least one surface of the PVA film 6 is laminated with the protect film after orienting the PVA film 6,

and then, post-heating is performed. In a concrete method for laminating, the PVA film 6 is laminated, during a thermal-processing step, with the protect film by using an adhesive in a state that both edges thereof are held. After that, both the edges are cut. As a cutting method, it is possible to use general techniques. For example, there are methods using a laser and a cutter of an edged tool or the like. It is preferable to carry out a heating process just after laminating the protect film, in order to dry the adhesive and in order to improve polarizing ability. Although conditions for the heating process are different in accordance with the adhesive, it is preferable to be 30° C or more in a case of a water borne pressure sensitive adhesive, and it is much preferable to be 40° C or more and 100° C or less, and it is much preferable to be 50° C or more and 80° C or less. It is proper to carry out these steps on a successive manufacture line for the purpose of improving performance and productivity. Incidentally, in the above, the PVA film 6 is laminated with the protect film in the tenter apparatus 4, and after that, both the edges are cut. However, the PVA film 6 may be laminated with the protect film after going out of the exit 18 of the tenter apparatus 4, and then, both the edges may be cut.

Although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various

changes and modifications will be apparent to those having skill in this field. Therefore, unless otherwise these changes and modifications depart from the scope of the present invention, they should be construed as included therein.